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MECHANICAL EQUIPMENT OF MODERN BUILDINGS*

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Secondary only in importance to the design of the enclosure and the planning of the interior arrangement of a building by the architect, stands the proper design and layout of the mechanical equipment by the engineer. It is the province of the architect to plan a structure best adapted to the site and the utilities to be housed, and it is the duty of the engineer to arrange the mechanical equipment to fulfil the requirements of the building and its services. It is the duty of them both to produce a building that will give a fair monetary return upon the investment if it is a commercial proposition, and to fulfil a need of whatever character it may be.

The province of the engineer is not so broad as that of the architect, but has sufficient scope to tax the ingenuity of most men, and the problem is becoming more complex each year.

While, of course, the character and the number of services to be provided will depend, to a large extent, upon the class of the building, every modern building will include several or all of the following services.

1st. Electric Generating Plant.
2nd. Plumbing, Water Supply and Drainage Systems.
3rd. Heating Equipment.
4th. Ventilating System.
5th. Electric Lighting, Power, and Sundry Electric Services.
6th. Elevator Service.
7th. Refrigerating Equipment.
8th. Sundry Minor Services.

Almost every building will have a system of plumbing, heating and electric services, and a great many of our buildings have some means of providing a positive circulation of fresh air and for the removal of vitiated air. If the building is a hotel or a club there will be a refrigerating system, and a great many of our large office buildings have some refrigeration, for cooling drinking water, or to serve a restaurant or lunch service.

Since it is impossible to give attention to the mechanical equipment of all different classes of buildings within the scope of one short

* Read before the University of Toronto Engineering Society.

paper, only the essential services of a modern office building will be discussed.

Plumbing

This branch of the work includes the distribution of hot and cold water throughout the building, the draining of the water from rain and melted snow from the roof to the sewer, and the disposal of the sewerage to the sewer system. Cold water is usually obtained from the city mains, and in most cases a storage tank is provided in the attic or above the roof of the building to serve as an emergency supply for domestic purposes and for fire protection, should the main supply be temporarily discontinued. Check valves must always be placed in the supply pipes from the street so that the building system will not be drained in the above emergency. If the city pressure is always sufficient to raise the water to the tank it will be allowed to flow in through a ball or float cock, which will automatically maintain a fixed level in the tank. If, however, the building is a tall one, it will be necessary to install house pumps to raise the water to the tank. From the storage tank and from the water mains in the lower section of the building, pipes are extended to all fixtures throughout the structure. In the case of a tall building the pipes will all connect to the storage tank and should also be brought down and connected to the system in the basement or the lower portion of the building. Valves should be provided to divide the upper portion of the system from the lower, so that the lower part may be supplied from the city pressure, while the upper stories are supplied from the tank. This arrangement will economize in pumping, as it will not be necessary to raise all of the water to the top of the building. Care should be taken to provide check valves in all pipes leaving the storage tank so that water cannot back up through these lines and overflow the tank in case the city pressure becomes unusually high, if it is a building in which the water is ordinarily elevated by means of pumps.

The drainage system from the roof of the building usually consists in extending pipes called rain water leaders from the gutters and low points in the roof down through the structure of the building and connecting same with the sewer piping. Every connection to the sewer must be provided with a running trap, which is kept filled with water to prevent gases from backing up through the piping. Refuse and water from the fixtures in the lavatories is discharged into soil stacks which extend down through the building and connect through the main house trap to the street sewer. The arrangement of the fixtures and the flushing devices must be such that ample water will be allowed to pass down this system of soil piping to keep same washed clear. Every fixture throughout the building is provided with a trap to prevent gases from escaping into the building, and on the opposite side of the trap from the fixture there is provided a vent connection which extends up through the building and is left open to the atmosphere at a point several feet above the roof. Great care should be given in the selection of drainage fittings so that there will be no pockets which will not drain clear. These fittings

are usually recessed and the pipes should be screwed in to the bottom of the counter bore.

To safeguard the public health, almost every city has more or less stringent by-laws governing the arrangement of the plumbing services and standardizing a great deal of the work. This, of course, leaves less opportunity for varying the equipment which must be provided in any given building.

If it is necessary to place plumbing fixtures where they cannot be drained by gravity into the sewer system, provision must be made for elevating the sewerage so as to discharge it from the building. There are several methods used, some of which consist of a centrifugal pump and a closed tank for the collection of waste matter. There is often more or less difficulty with this method of handling sewerage due to incrustation in the pump. In most of the important installations a pneumatic ejector is used. This equipment consists of an iron tank located so that the sewerage will flow to same by gravity. From the bottom of a tank a pipe is connected to the sewer. Both the supply and discharge pipes are provided with check valves. A supply of compressed air is furnished by a compressor. When the receptacle is nearly full a float or air lock automatically operates the valves and admits air to the top of the vessel and the contents is forced through a discharge pipe to the sewer, and when the tank is emptied the flow of air is automatically cut off and the equipment is ready for the beginning of another cycle. There is also a system of sewerage disposal which utilizes the energy of the sewerage from the upper floors to compress the air, which in turn is used to raise the sewerage from the lower section of the building. This method, however, has not been extensively used on this continent.

Hot water for domestic purposes is usually heated by passing it through a tank which contains a steam coil. This coil should generally be made of brass or copper. If, however, steam is not available throughout the year, a jacket heater, using coal as a fuel, or some form of gas heater will be installed. Gas may be consumed at a higher efficiency than coal, and it is more convenient to handle, but with coal at $8.00 per ton gas must cost only 20 to 25 cents per thousand cubic feet in order to be on a par with coal in fuel cost.

The hot water system should always be under thermostatic control and except in the case of hotels and laundries, a temperature of about 160 degrees F. is maintained. The dish washing service in hotels and the washers in laundries usually require water at a temperature higher than that given above. For these services the water is often heated almost to the boiling point, and in some cases the steam is blown directly into the washing tank. There are several forms of thermostatic regulators for controlling gas burning equipment in a satisfactory manner, but in selecting a design great care should be given to the pilot light equipment to insure against it becoming extinguished and the building filled with gas. No damper should be allowed in the smoke flue from an automatically controlled gas burning equipment. The steam supply to heater

and the draught dampers of the jacket heaters may be controlled by a thermostat placed in the storage tank.

The cold water supply to the domestic heater is usually obtained from the gravity tank, if it is a tall building, and circulating pipes should be brought back to the heater from the ends of all hot water branches, and the system should be arranged so that the water will circulate by gravity throughout the building, unless it is an extremely large installation, or the water has to be transmitted through a group of buildings, in which case it will generally be necessary to install a circulating pump. In any case the water must not be allowed to remain still in the pipes, as it will become cool and cause waste and inconvenience, for it will be necessary to run a large amount from the faucet before the water becomes hot enough to use.

Heating

In all the colder climates it is necessary to heat buildings throughout the winter season. The temperature which is to be maintained will depend to some extent upon the occupation of the inhabitants, and also upon the race and customs. On this continent a temperature of 70 degrees F. is usually considered desirable for all buildings where people are not engaged in manual labor. In France and England a temperature of from 65 to 68 is considered satisfactory, and under most conditions this lower temperature is probably more desirable for health than is the higher.

Steam, hot water, and heated air, are the mediums commonly utilized to transmit heat from the generating plant throughout the building. Steam is used more than the others. It is adapted to smaller buildings and is practically the only one used for very tall structures, but is difficult to regulate to meet the varying heating requirements. Hot water is well adapted to small installations, in which it is usually allowed to circulate by gravity, and to large heating systems, where forced circulation is obtained by means of pumps, or the so called rapid circulation by allowing some steam to be generated and pass up the pipe, thereby reducing the static pressure in the flow pipe. Hot water has the advantage of easy regulation. In tall buildings the pressure due to the static head of the water will be excessive on the lower floors, and for this reason buildings taller than 6 or 8 storeys are seldom heated by hot water.

The hot blast system, using hot air which is circulated by means of a fan, has been extensively used for heating factories and may be used for heating large buildings. This method has not been used to any extent for heating office buildings, although almost every large office building has some ventilating equipment to furnish fresh air to the lower floors, and this same equipment is very often used to warm these floors. In 1910 the writer installed a fan blast system throughout a 12 storey building, but there are very few installations of this character where the heating requirements are severe.

In order to transmit and distribute air for heating throughout a building it is necessary to run large ducts, and in a modern office building it is very difficult to find space for these, although if the

floor space given up to radiators and piping is all considered, the space lost due to fan blast heating would probably not be greater than with direct radiation.

The modern forced blast heating and ventilating unit consists of tempering coils, an air washer, a centrifugal fan, and reheaters, with a system of galvanized iron ducts to distribute the air.

The temperature of the air having been raised to 50° to 55°F. by the tempering heater, passes through the air washer to the fan, which forces it through the reheater into the hot air chamber or around the by-pass in the tempered air chamber. A thermostat located in the tempered air chamber regulates the amount of steam supplied to the tempering coils and maintains the tempered air at a constant temperature, and a thermostat in the hot air chamber regulates the steam supply to the reheating coils and maintains a constant temperature in the hot air chamber, or located in the cold air supply duct regulates the reheaters to meet the requirements. Each air duct is connected to both the tempered and the hot air chambers and has a damper in each connection. These dampers are connected by a bar and arranged so that opening one closes the other. A thermostat located in the room which is supplied by the duct controls the position of these dampers and in that manner allows the desired quantity of hot and tempered air to enter the room to maintain a constant temperature and at the same time give a constant air supply.

Incidentally, this apparatus, if properly operated, will give an approximate humidity control, for the air washer will very nearly saturate the air passing through, and will therefore give a nearly constant percentage of humidity in the rooms supplied so long as the automatic regulating equipment is in satisfactory operation, and the air outside does not contain more than the desired amount of moisture.

The supply registers are usually placed upon interior walls and about eight feet from the floor for average rooms, and the exhaust, or vent registers, are placed near the floor unless there are fumes or smoke to be removed in which case a part of the outlet openings may be placed near the ceiling.

No positive fresh air supply is usually provided in lavatories, but an exhaust system should always be provided and arranged to remove air from above each fixture.

There are too many details to the various kinds of heating system to be covered in one paper, and I will give attention only to vacuum heating, which is the usual method in large office buildings.

In this method steam is supplied at a very low pressure, often not appreciably above the atmosphere. Some form of vacuum trap which will allow the water and air to pass but will close as soon as steam enters it, is placed in the drip or return connection to each radiator.

Vacuum Pumps are connected to the return mains and from 5 to 15 inches of vacuum is maintained. This causes the water and air to quickly flow from the radiators and allows the steam to make efficient use of the heating surface.

With this system it is not necessary to have all the return piping drain to pumps, as lift fittings may be installed and the water raised.

It is very common practice to extend a steam main to the top of the building, provide a circuit around the attic and extend pipes down the columns to supply radiators upon the various floors and to collect the condensation by means of a system of return risers, also on the columns and extending down to the basement where they are connected to the return mains or joined in groups and extended back to the return header, which is connected to the vacuum pumps.

The steam supply to the radiators may be regulated by throttling so as to have a partial vacuum in the radiators, and to operate under a temperature lower than 212.

Vacuum heating has led to the development of a large number of thermostatic traps and water seal valves. The thermostatic trap usually has some form of motor which contains a vessel filled with a liquid which will generate a pressure by boiling at the desired temperature and by expansion close the passage.

In any heating system one of the most difficult questions to handle is the disposal of the air from the radiators and the piping. The air must either be discharged through automatic valves, placed on each radiator and wherever there is an opportunity for air to collect, or it must be drawn back by some mechanical means through the return system. In vacuum heating the pumps exhaust the air from the return mains at the same time that the return water is removed from the system, and the apparatus is nothing more than a wet vacuum pump arranged to handle hot water. These pumps are usually automatically controlled so as to maintain the desired vacuum on the return system, and the pumps are allowed to discharge into a receiving tank where the air is separated from the water and allowed to escape through a vent pipe. The water is usually drawn from the receiving tank by the boiler feed pumps and returned to the boiler.

Vacuum heating is somewhat more economical than so called gravity steam heating, because the steam may be distributed throughout the building in a more uniform manner, and not have excessive back pressure in the exhaust piping of the steam power equipment. Also, by lowering the pressure, a condition better adapted to moderate outdoor temperatures may be obtained.

Thus far it has not been found practical to arrange any method of adjusting the amount of heating surface of a given unit which is to operate, and the only means of regulation at the present time is to decrease the temperature of the entire radiator, either by decreasing the pressure or by cutting off the steam at intervals. Increasing the number of radiators in each room allows for partial regulation by turning on or off some of the units. However, any increase in the number of units will increase the cost of the system, though the heating surface is not made greater. The labor and material, other than the radiators necessary to install a steam heating system, will usually amount to from 70 to 80 per cent. of the total cost, and every additional unit added will increase the cost of the

system. In factory buildings it is possible to economize in first cost by using very large units in the form of pipe coils, but in office buildings it is necessary to have at least one radiator in each room, and in a great many rooms where there is a probability that tenants will ask to have changes made by dividing the room into several smaller ones, it may be desirable and economical in the end to install two or more small radiators.

All the piping in the heating system of a modern office building may be concealed in the structure of the building unless there are architectural features which make it impossible to do so. The risers are usually enclosed by providing chases in the walls or furring out to cover them, and the branches to the radiators are placed in the concrete floor structure.

One of the most important things to be considered in the installation of a heating system is the proper provision for the expansion and contraction of the piping. Provision is usually made for the pipe to have a slight movement by taking off each branch in such a manner that there will be a swing connection formed, built up of elbows and nipples, and in buildings which are more than 8 storeys in height it is usually necessary to provide an expansion connection in the body of the risers. The pipes which are concealed in the cement floor structure are covered with asbestos and usually have a sheet metal covering or gutter laid over the asbestos covering before the cement is poured over them. The asbestos covering will allow for the necessary expansion in the short runs which are placed in the floors.

Electric Services

The electric circuits, throughout a modern building, which serve the various outlets for lighting and in some cases power, are always enclosed in wrought iron conduits concealed in the structure of the building. The layout is usually arranged so that each floor or a small section of the building will be provided with a panel box containing switches and fuses to control and protect the secondary circuits which are placed in the floor and ceiling and furnish current for the lighting outlets. These secondary circuits usually are arranged so that each will supply not more than 660 watts. Modern lighting systems usually operate on 110 to 115 volts either direct or alternating current. If direct current is used it is common practice to install the three wire system, arranged to transmit current at 230 volts between the main leads, and to have a neutral wire with a difference of potential of 110 to 115 volts from each main lead. The layout must be arranged and the system balanced so that the difference in load between the two sides of the circuit will be reduced to a minimum. The modern three wire electric generator provides for a difference in load between the two sides of about 25 per cent., and it is necessary to use a two wire 230 volt machine, a motor-generator balancing set will usually be required to provide for the difference in load to prevent burning out lights.

The electric conduits usually terminate in outlet boxes concealed in the structure of the building. The fixture wire or the connec-

tion to the receptacle is made in this outlet box, and the whole is concealed either by a plate or by a part of the fixture.

Power service is usually provided in the same general way, except that 230 volts or higher is very commonly used, and each motor, unless it is a very small unit, has in its outlet box a cut out consisting of fuses and possibly a knife switch.

In every modern building there are sundry minor electric services such as a telephone system, call bells, telegraph calls, watchmen's time clock systems and fire alarm circuits. It is very common practice to arrange a system of risers extending up through the building and connecting to distribution panels placed upon each floor to provide telephone service. In buildings where the furniture and fittings are fixed it is common practice to extend one-half inch and three-quarter inch conduits from these distribution boxes to telephone outlets in the various rooms and offices, but in a great many office buildings where it is impossible to determine where the tenants will desire their phones to be located it is common practice to provide a wiring moulding or gutter around the entire corridor, and to conceal the telephone wiring in this gutter and to make a connection therefrom to the distribution panels. The telegraph and call bell services are usually installed in very much the same manner as the telephone system. None of these minor electric services are ever allowed to be placed in the same conduits with lighting or power circuits. The watchman's recording system usually consists of one or more magnetic stations placed upon each floor and located in such a manner that it is necessary for the watchman to pass through almost the entire building in order to visit all the stations. A recording system is provided in some part of the building which automatically records the time at which the watchman visits and rings each station.

Elevator Service

Most modern buildings having more than three storeys are equipped with some form of elevator to quickly transport passengers from the street level to all floors. The importance of the elevator service increases with the height of the building, and in the "skyscraper" it forms one of the most elaborate and expensive parts of the mechanical equipment.

The worm geared and the gear-less 1 to 1 traction type electric elevators and the plunger type hydraulic elevators are used in modern buildings, and the demands of the tall structures have led to the development of elevators to run as high as 700 feet per minute. The latest type of elevator is the 1 to 1 gear-less electric traction, which is operated by a 35 h.p. motor running at from 40 to 63 R.P.M., and operating a car having a floor surface of approximately 30 square feet at a speed of about 550 feet per minute with a load of 2,500 pounds.

A canvass in 1910 of 18 New York office buildings, having from 9 to 25 storeys, shows that there are 149 elevators in service, that the cars have from 25 to 30 square feet of floor surface each and that there is an average of 1 elevator per 16,600 square feet of rent-

able floor surface. In the Woolworth Building, New York, there are 29 electric passenger elevators. Two of these have a run of 679 feet from the street level to the 53rd floor, and have a capacity to lift 2,500 pounds, at a speed of 700 feet per minute. This elevator installation is a striking example of the advancement of the art in less than a half century.

Minor Services

There is often a demand for artificially cooled drinking water in an office building and in some cases a small amount of refrigeration is desired in connection with a restaurant or lunch service. A small ammonia compression machine can conveniently be installed to meet these requirements.

A vacuum cleaning plant is installed in most office buildings. Connections should be provided so that all parts of floors to be cleaned can be reached with 50 to 75 feet of hose, but in old buildings it is not always possible to accomplish this distribution, and very long lines of hose must be used. In one of Toronto's largest department stores, vacuum cleaner tools operate upon 200 feet of hose, but under this condition the service is not satisfactory.

In preparing specifications for the mechanical equipment of a building, the engineer should give close attention to the division of the work between the several trades and each contract should definitely state exactly the scope of work to be covered and where connections are to be made to the other trades. There often arises such questions as, who provides the foundations? Who does the electric wiring to the motors? Is contractor to paint apparatus after it is all installed? Is contractor to make connections to steam exhaust and drain piping? What operating conditions are guaranteed? One of the most difficult parts of the engineer's duties is to avoid interference between the different services. Alterations in the building often disturb the layout of the equipment and you will find the ventilating ducts, the plumbing and steam pipes all attempting to occupy the same space.

Four of this year's graduates in mining engineering, viz., W. E. Milligan, Toronto, S. D. Ellis, Victoria, B.C., R. W. Young, Bothwell, and S. A. Lang, Toronto, have accepted positions in the metallurgical works of the Braden Copper Company, Chili, South America.

R. W. Downie, '16, is with the Department of Mines, Forests and Lands at Fort Francis, Ont.

J. W. Peart, B.A. Sc., '13, is with the Waterworks Commissioner at London, Ont.

A. A. Scarlett, B.A. Sc., '13, is with the Ontario Hydro-Electric Power Commission at their experimental station on Strachan avenue, Toronto.

THE PURIFICATION OF PUBLIC WATER SUPPLIES

C. H. R. Fuller, B.A.Sc.

The interest attaching to the purification of public water supplies originated principally in the proof, which has been furnished by medical men, that some zymotic diseases are communicated through drinking water. The communicability of Asiatic cholera and typhoid fever forms one of the fundamental principles of modern sanitary science, which each year is becoming more generally accepted and is probably now universally recognized. The ancient Romans appreciated this fact when they spent much time and labor to bring their water supplies through magnificent aqueducts from unpolluted sources. In some cases the water was even passed through artificial reservoirs to purify it by sedimentation.

The most important use of a public water supply is the furnishing of suitable water for domestic purposes. The value of a pure supply to a city compared with one polluted by sewage can scarcely be overestimated. Pure water is of great value to small towns and villages as well as to large cities. In some cases the supply is designed solely for fire protection, when pure water is to be desired quite as much as for a city supply. An adequate or copious supply is not to be considered if it means that quantity is procured at the expense of quality. This fact may be noted on comparison of American and European supplies. The consumption of American municipalities per capita is very much higher than that of Europe, but in quality the European water supplies excel American standards.

A suitable supply for drinking purposes should be pleasant and palatable, and if possible, free from color and turbidity. The latter requirements are not binding, since many peaty and turbid waters may be safely used. Waters heavily charged with mineral matters should not be used as they are supposed to produce diseases of an intestinal and gastric nature. The most important requirement of a water supply is to have it unimpaired by organic refuse of human, animal, or vegetable origin, as this contains germs of a character which are dangerous to human existence. For this reason the use of surface waters in populated districts where sewage is discharged into the rivers and lakes is dangerous to public health and should be first subjected to a system of artificial purification.

Bacterial Content of Various Waters. The micro-organisms causing disease, which are present in water and are the polluting elements, are the pathogenic bacteria. The bacterial pollution of a stream is always greater during high-water stages as the more rapid flow increases the carrying power and much more dirt is carried along with the bacteria that accompany such a disturbance of soil particles. Theobald Smith found that the Potomac River water contained the following number of bacteria at different seasons:—

Dec.	Jan.	Feb.	March	April	May	June	July	Oct.
967	3774	2536	1210	1521	1064	348	255	75

The same general result was noted by the Massachusetts State

Board of Health on the Merrimac River water. It appears as follows:—

	Average No. of Bacteria per C.C.
January	3,800
February	3,700
March	3,500
April	1,600
May	2,600
June	15,100
July	4,400
August	5,000
September	13,800
October	4,200
November	7,800
December	11,200

According to Johnson, the bacterial content of uninhabited streams like the Saguenay in Canada is not materially different from that of the rivers flowing through farming regions, although where a stream flows through a city or town of any considerable size, especially if it receives the sewage of the same, the amount of pollution is naturally much increased. The following data were determined for the Isar River at Munich:—

	No. of Bacteria per c.c.
Above the city of Munich	531
150 feet above sewer outfall	1,339
Directly opposite sewer outfall	121,861
450 feet below sewer outfall	33,459
Ismaning (8 miles below sewer outfall)	9,111
Freising (20 miles below sewer outfall)	2,378

Not only is there a marked increase in the bacterial content of the river, but also it is evident from the above table that a large part of this pollution is lost in a comparatively short time, as it takes only eight hours for the current to reach Freising, twenty miles below.

A few American streams have been more or less perfectly studied in this regard. The most extensive study yet made was that on the Illinois River in connection with the Chicago Drainage Canal. The waters of this stream were studied bacteriologically, both before and after the opening of the Sanitary Canal, in order to determine whether the introduction of the sewage of the city of Chicago would exert any deleterious influence on the quality of the St. Louis water supply drawn from the Mississippi. The data showed that the bacterial reduction is continuous for a distance of 160 miles, until the river receives at Wesley City the large amount of refuse of Peoria.

The Relation of B. Coli to Polluted Waters.—In the case of most water borne diseases, it is generally admitted that the organism causing disease is more or less distinguishable from other bacteria, although in typhoid fever, the "bacillus typhosus" is closely related to an intestinal organism called "bacillus coli communis." When the latter are found in water, it is an indication of intestinal discharges and the water supply should not be regarded as safe. The Massachusetts State Board of Health found the

numbers of bacillus coli communis in the Merrimac River water in various years as shown in Table 1.

YEAR	No. of Samples Tested for B. Coli	Average No. of B. Coli per c.c.	Per Cent Containing B. Coli
1898	163	49	98.2
1899	180	47	99.4
1900	199	87	99.5
1901	144	40	97.9
1902	196	73	99.0
1903	136	53	98.5
Total:	1018	58	98.7

TABLE 1.

It will be noticed that B. Coli has been present in all samples of the river water. In the water at the intake of the Lawrence City filter and in the water as it flows to the filters, higher numbers of B. Coli per cubic centimeter have been found during the summer months than during the winter months and in the same water after receiving sewage of the city of Lawrence, the numbers of B. Coli have been higher in the summer season.

Table 2 shows interesting results of tests for B. Coli in surface waters. These show that the surface waters of inhabited localities nearly always contain B. Coli. This is a positive indication of sewage pollution.

Number	Area of water Surface in Acres	Area of Water Shed in sq. miles	Population of water shed per sq. mile	Total population per sq. mile.	Number of Samples	Per cent. cont. B. Coli	Av. No. of Bacteria per c.c.
1*	243	5.00	1,400	7,000	30	13.3	612
2	85	0.94	356	380	29	3.5	319
3*	222	4.96	60	290	44	2.3	48
4*	621	5.40	50	270	43	4.6	66
5	38	0.32	47	15	45	0.0	133
6	379	5.18	42	148	43	0.0	107

* Shores used for pleasure resorts.

TABLE 2

Typhoid Outbreaks.—A most instructive case of this simultaneous development of disease due to sewage pollution is seen in the series of typhoid epidemics that occurred in the towns in the valley of the Mohawk and Hudson rivers in 1890-91.

In July, 1890, typhoid became epidemic in Schenectady and continued until April, 1891. Seventeen miles down the Mohawk

at Cohoes, a city of about 22,000, typhoid broke out in October 1890, and before April 1891 there had been 1,000 cases. The disease was exceptionally mild; but notwithstanding this, the typhoid death rate for the period of the epidemic was equal to the annual death rate of 45 per 10,000 inhabitants, or about 12 to 15 times the normal.

West Troy, taking its supply also from the Mohawk above Cohoes, suffered from an epidemic from November 1890, till February 1891, except for a brief period when the supply of the village of Green Island was used. Six miles below West Troy is Albany. Here, again, the disease became epidemic in December, lasting until the spring. Waterford, Lansingburgh and Troy took their supply from other sources than the Mohawk or the Hudson below the junction with the former stream. So far as this outbreak was concerned, they escaped entirely.

The progressive development of the disease in all those towns that used water from the Mohawk, and its absence in other towns situated on the Hudson that were supplied from other sources, shows conclusively the influence which the sewage pollution of Schenectady and other towns had on the distribution of the disease.

Necessity of Purification.—Disasters have occurred from drinking sewage polluted water usually because of the failure to purify a surface supply exposed to pollution or of the inefficiency of the purification. The following comparison of typhoid rates in different towns before and after purification will show the marked necessity of taking precautions against outbreaks and the value of purification.

Cohoes.—In February, 1908, the Mohawk river pollution was investigated and the need of a pure supply to lower the high typhoid rate was pointed out. Water filtration was strongly urged, and in 1911 a filter plant was installed. Notice the reduction in rate in 1912.

Year	1900–5	1906	1907	1909	1910	1911	1912
Typhoid rate per 100,000........	92.9	57.8	62.0	82.2	76.8	108.5	48.0

This is a good example of the necessity of having a system of purification.

A consideration of the case of Elmira will show the necessity of having an efficient system of purification. In 1896, as a result of a serious epidemic, a filtration plant was installed. In 1909, an investigation showed continued high rates of typhoid and it was recommended to increase the efficiency of the plant. After this the operation was improved through the use of hypochlorite, which was used during the two succeeding years. Notice the reduction in the rate of 1909.:

SEDIMENTATION PROCESSES

Year	1900–5	1906	1907	1908	1909	1911	1912
Typhoid rate per 100,000........	45.5	44.7	28.0	30.7	33.5	26.9	13.3

Other examples of the same kind will be found in the records of New York, Niagara Falls, Ogdensburg, etc.

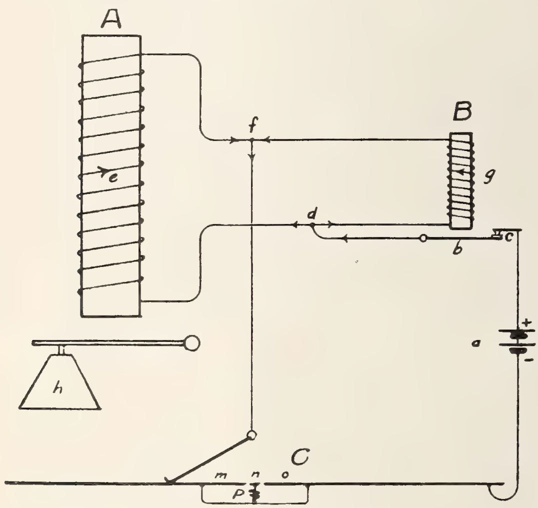
(To be continued in next issue)

LOW-VOLTAGE HIGH-SPEED RELEASING MAGNET

PROFESSOR H. W. PRICE, B.A.Sc.

Occasionally it happens that, when a mechanism appears impossible for specified service, the very property of it which caused difficulty can, if properly utilized, be made to correct all the troubles, and yield results that are better than one's most optimistic wish. A case in point is offered herewith:

Some time ago the writer had necessity to design an automatic mechanism including an electromagnet which was to start the mechanism into its cycle of operations every time the current in a control circuit through the magnet was momentarily destroyed or even reduced to half or less than half its normal value during a time not to exceed one-thirtieth of a second. This problem presented some real difficulties, because the magnet was required efficient so as to work with minimum drain on low-voltage batteries, and large enough



to securely resist a normal pull of 100 pounds on the armature. These two demands made impossible any design without a great many turns of conductor, and considerable inductance, which involved a magnet relatively slow in releasing its armature, liable to cause a small arc at the control contact, and with not the faintest chance of releasing because of a one-thirtieth of a second interruption of control current.

After some consideration a novel scheme was hit upon of making the large stubborn magnet work in combination with a small high-speed magnet, somewhat as an elephant and a bronco might work in combination, pulling a 6-foot whiffle-tree and a logging chain, the chain 5 feet from the bronco's end and one foot from the elephant's end of the whiffle. If, while the pair were ambling along

at eight miles an hour, the chain caught solidly in a rock crevice, the bronco would suddenly be projected backwards along the trail at about thirty miles per hour before his mate could commence to stop.

In the diagrammatic figure herewith, *A* is the large, efficient, relatively slow-acting magnet designed entirely for its work with the 100-pound pull on the armature. *B* is a small quick-acting magnet designed entirely from the speed point of view. The two magnets are connected in parallel to operate from common battery *a*. At *b* is shown the light armature of *B*, which when attracted, stops mechanically against contact *c* through which the current to excite both magnets must pass. *C* represents that part of the control circuit in which a complete or partial opening may be made at any time. It is shown arranged as we had it for testing purposes, and was capable of opening the circuit for periods as short as one-five-hundredth of a second.

Normally, battery *a* sends current through contact *c* to junction *d*, thence in senses *e* and *g* around cores *A* and *B*, holding armatures up to support pull *h* and hold closed contact *c*. Any sudden break or reduction of current resulting from changes at *C* tends to reduce both currents *e* and *g*. Coils *A* and *B* both object to sudden reduction because of and in proportion to their inductance. Coil *A* having much the greater inductance persists momentarily in maintaining its current in the same sense *e*, and in so doing forces reversal of current *g* and the magnetism in small magnet *B*. This reversal of magnetism cannot occur without passing magnetism and magnetic pull on armature *b* through zero value, of which instant a spring takes advantage by *starting* armature *b* to move away from the poles. Since contact *c* serves also as the mechanical stop from which the armature started to move, the battery circuit is now absolutely open, and remains so whether closed again or not at *C*. Coil *A* may take its own time, but must release the pull on *h*.

The results obtained from this combination were surprising. An interruption at *C* for one-four-hundredth of a second would invariably trip the armature supporting *h*, leaving a safety factor of 13 over the speed required, one-thirtieth of second. Magnet *A* alone required one-half second to release after break of current through it. Further, as contact *c* always opens at the instant of zero current, there was no possibility of arcing at the contact regardless of design or size of the big magnet.

The automatic mechanism for re-setting the armatures for the next cycle of operations is not shown.

It may be of interest to know how one could accurately time a current reduction or break of one-five-hundredth of a second. Mechanism *C* was arranged for the purpose. Two copper straps *m* and *o*, were electrically connected, but mechanically separate from a short strap *n* by one-thirty-second of an inch air gaps. If it were desired to *open* the circuit for one-four-hundredth of a second, *n* was electrically disconnected from *m o*, and the contact arm moved uniformly from left to right at such speed as to spend one-four-hundredth of a second on *n* and the two gaps. Any slight arcing would shorten

instead of lengthen the time of opening, so that time of opening was certainly not more than one-four-hundredth of a second, and might be somewhat less. If it were desired to *reduce* current for a similar test, any desired resistance was inserted between *n* and *mo*, which resistance was therefore inserted in series with the magnets while the contact arm was passing over *n*.

THE INDUSTRIAL MANUFACTURE OF HYDROGEN

J. E. Breithaupt, '15

Hydrogen is now sold at Griesheim & Bitterfeld, in Germany, at 10 pfennigs per cubic metre, one cubic metre weighing 89.6 grams. This is about 12 cents per pound. As hydrogen constitutes 17.6% by weight of ammonia, the quantity required to produce one pound of ammonia would cost 2.11 cents, and to produce one kilo 4.65 cents. Further, the hydrogen necessary to produce one kilo of combined nitrogen in the form of ammonia, i.e., 1.21 kilos of ammonia, would cost 5.62 cents. With ammonium sulphate selling at a rate which gives its nitrogen content a value of about 13 cents per pound, the value of nitrogen present, after deduction of the cost of the sulphuric acid, is well above 12 cents per pound. There is evidently here an unusually wide margin under existing price conditions to cover the expense of manufacture as nitrogen may be obtained in quantities at 0.32 per pound, or less. Where circumstances permit, the direct use of the hydrogen now liberated in the electrolytic manufacture of chlorine, and the alkalies, as at Griesheim and Bitterfeld, an admirable utilization of what is now often a waste produce, could be attained. Germany produces annually ten million cubic metres of hydrogen (896 metric tons) as a by-product of the electrolysis of the alkaline chlorides. The same can be said of the hydrogen liberated in the electrolytic production of oxygen for commercial purposes from solutions of alkaline hydronides.

The Machinenfabrik Oerlikon is now producing hydrogen on a large scale by electrolysis, using a solution of potassium carbonate as electrolyte. This hydrogen contains 1% of oxygen, while the oxygen produced at the same time contains 2% of hydrogen. The Heraeus Co., in Honan, uses as electrolyte a 20% solution of caustic potash maintianed at a temp. of 60°-70° C. Both firms require an expenditure of 6 kilowatt hours per cubic metre of hydrogen.

Where electric power costs 80 marks, or $19.04 per horse power year, as is frequently the case in Germany, this means an outlay 7½ pfennig per cubic metre of hydrogen for electric energy or 9 cents per pound. As each cu. metre of hydrogen involves a production of one half cu. in. of oxygen, valued ordinarily at 12 pf. per metre, it is possible to produce hydrogen electrolytically, with great economy, at all points where there is a continuous demand for oxygen in large quantities.

This electrolytic method is probably the oldest and the best established on an industrial scale. The great increase in the demand

for hydrogen has, however, brought forth many new processes, a few of which I shall describe.

G. F. Jaubert has taken out several patents for processes and apparatus for the preparation of hydrogen by auto combustion. He uses metals such as aluminium or zinc, or their alloys, or metalloids, such as silica or carbon, or their compounds, mixed with alkali or alkaline earth hydroxides in the form of dry powders. These yield mixtures quite stable at ordinary temperatures. If, however, reaction be induced by local application of heat, hydrogen is evolved and sufficient heat is developed to cause the propagation of the reaction throughout the entire mass. A suitable apparatus consists of a tube closed at one end by a screw cap and having near this end an opening, also with a screw cap, through which a quick mass or piece of hot iron may be introduced to induce the commencement of the reaction. The other end of the tube is formed by a perforated plate, through which the hydrogen evolved passes into a chamber packed with filtering material, and thence into an annular space formed between the tube and a jacket extending nearly the whole length of the latter. The hydrogen accumulates in this annular space under pressure and is withdrawn as required through a suitable outlet.

Another of Jaubert's patents is for a process in which certain alloys of iron, especially ferrosilicon, containing 75% silicon, when heated to a very high temperature are capable of decomposing steam with sufficient evolution of heat to carry on the reaction $3\ Fe\ Si_6 + 40\ H_2 0 \longrightarrow Fe_3 0_4 + 18\ Si\ O_2 + 40\ H_2$.

The reaction may be regulated by the addition of lime, which has the further advantage of forming an easily workable slag. The apparatus comprises a refractory chamber surrounded by a steam coil, the delivery end of which terminates in a series of injectors which admit steam into the chamber. A feeding hopper is provided at the top of the chamber and a door for the withdrawal of the slag at the bottom.

The Internationale Wasserstoff Aktien-Gesellschaft, of Frankfurt, has established on an industrial scale, the manufacture of the gas by passing steam over glowing iron. Pyrites is found by the company to be the best material for use in the alternating operations of reduction and oxidation, as it retains its porous character. There is no tendency to fall to powder or to cake and thereby delay the process of reaction, more especially when undergoing reduction to the metallic state.

Water gas, which contains on an average 48% hydrogen, 43% carbon monoxide, 4% carbon dioxide, 4% nitrogen and small amounts of oxygen and methane, is an economical source of hydrogen. The oxides of carbon may be removed by suitable absorbents, such as alkaline hydroxides, cuprous chloride, etc. Frank passes the gas over calcium carbide at 300° C., securing an almost pure hydrogen. More economical is the separation by the use of compression and refrigeration, analogous to the method used in the separation of the constituents of the air. A company has been organized in Germany to produce hydrogen by this process, using for the purpose, when possible, the Dellwick water gas, which averages 51% of hydrogen and

42% of CO. Such a gas in the Linde apparatus easily yields a product containing 97% hydrogen, 1% nitrogen or less, and 2% carbon monoxide. The small amount of the latter can be easily removed by passing the resultant gas through a cuprous chloride solution. From this solution it can afterwards be expelled by boiling, supplying perfectly pure monoxide for use as a fuel gas. By a recently patented process the residual carbon monoxide can readily be removed by bringing the gas, while under high pressure, in direct contact with soda lime. The hydrogen is then over 99% pure, containing less than 1% nitrogen as the only impurity. The remainder of the carbon monoxide, originally present in water gas, is secured in this process, likewise in a form admirably adapted for fuel purposes, the liquefied gas containing 85%. It serves to supply the necessary power for the entire operation.

The 99% hydrogen gas can be furnished at a maximum rate of 12 pfennigs per cu. metre or 14.4 cents per pound. The purer gas, containing 99.2-99.4% hydrogen, would cost 15 pfennigs per cu. metre which is 18 cents per pound. This, the Linde-Frank-Caro method, so named after the inventors of the different features therein combined, has been installed in different parts of Germany and is doing good work. The cost of production on a large scale will ultimately sink materially below the rates given.

A patent entitled "Construction and method of operation of hydrogen gas producing apparatus" has been taken out by H. Lane. In his process hydrogen is prepared by passing steam over heated iron, or other easily oxidisable material, and the oxidised product is then reduced by means of a reducing medium such as water gas. In practice it has been found that the latter reaction takes considerably longer than the generation of hydrogen; the process is therefore carried out in three or more groups of retorts, the greater part of which are constantly subjected to the action of reducing gases for the regeneration of the iron, or other hydrogen producing substance. The retorts communicate with one another by means of suitable pipes, fitted with controlling valves, so that steam or the reducing gases may be admitted as required. The hydrogen which is evolved during the first few minutes of the operation, being impure, is diverted from the collector of pure hydrogen, and mixed with the water gas used for reduction. A considerable excess of water gas is used for this purpose and it undergoes a very thorough system of purification before being admitted to the retorts; the excess, which issues, is freed from the accompanying steam and used again. Means are provided for forcing hot air through the apparatus, which is done periodically between the two reactions so as to burn out objectionable impurities, especially sulphur.

Another process which is quite similar to this has been patented by A. Messerschmitt. The process depends upon the alternate oxidation of spongy iron by means of steam with the evolution of hydrogen, and the reduction of the resulting iron oxide by means of reducing gases such as water gas. An upright, cylindrical, unlined, iron reaction chamber is suspended inside a refractory, masonry furnace chamber, with which it is in open communication at the bottom, the

lower end of the cylinder being provided with a grate to support the column of reacting mass. The width of the reaction cylinder is relatively small, so that the mass may readily be heated from all sides, and the furnace chamber is provided with a checker-work of refractory masonry constituting a super-heater. Both the reaction chamber and the furnace chamber are capable of being heremetically sealed, and are provided with a system of pipes and valves, whereby either steam or water-gas, may be introduced as required into the reaction chamber, the furnace chamber, and a chimney communicating with the atmosphere respectively. In addition, an air supply pipe communicates with the furnace chamber, and the pipe leading from the top of the reaction chamber can be put into communication with a gas-purifier and the steam-raising plant. The process is carried out in three phases. Water gas and air are first burnt in the furnace chamber until the mass inside the reaction cylinder has reached the required temperature. The air supply is then cut off and water gas, flowing in at the bottom of the furnace, becomes strongly heated, traverses the mass of iron oxide through the open, lower and in an upward direction, and finally escapes at the top through the pipe system, which connects with the steam-raising plant, where any unburnt reducing gases are utilized. When the reduction of the iron oxide is complete the supply of water gas is shut off and steam is introduced, first into the bottom of the furnace to sweep out any residual gases from the second operation (the furnace being in communication with the exit chimney while this is going on) and then into the top of the furnace chamber from which it passes downwards through the super-heating system, and finally upwards through the mass of spongy iron. Hydrogen issues from the top of the reaction chamber through a purifier into a gasometer. The iron reaction chamber may take the form of two concentric cylinders, the reaction mass being in that case charged into the annular space between the two. The cylinder or cylinders in question are periodically heated and reduced by means of the reducing gases, both inside and out.

In another process in which hydrogen is manufactured by the alternate decomposition of steam by metallic iron, and subsequent reduction of the iron oxide produced, by means of some reducing gas or substance, alloys of iron with manganese, chromium, tungsten, titanium, aluminium or other similar elements are employed as the primary materials. These have the advantage that they are not fusible, do not soften, and do not form fusible or soft compounds with iron or its oxides. In place of alloys, mixtures of iron or its oxides with the other elements specified, or their oxides, may be employed, for instance, in the form of briquettes. The same materials may be used for the manufacture of nitrogen, or of mixtures of nitrogen and hydrogen, by substituting air, or a suitable mixture of air and steam for steam alone in the oxidizing operation and eliminating the excess heat, if necessary, by external or internal cooling.

In the process of N. Caro portions of the water gas are burned in different parts of the reaction chamber, so that in addition to the reduction of the iron oxide, a super-heating of the reduced iron is

affected. It is claimed that by working in this manner the gas-making period can be considerably prolonged.

The Badische Anilin and Soda Fabrik prepare hydrogen by the alternate action of steam on iron and of reducing gases on ferric oxide. The iron soon looses its activity owing to fritting, etc. As remedies are claimed, the use of fused iron oxides, especially in conjunction with refractory and difficultly reducible oxides such as magnesia, zirconia or the like. The iron oxides are prepared by the fusion of metallic iron in the presence of air or an oxidising agent. Fused iron oxides are also used in conjunction with a silicate or a similar naturally occurring mineral, such as magnetite.

By the Cedford process the greater part of the CO in the water gas is removed by liquifaction and fractionation and can be used for heating purposes. The residual gas, rich in hydrogen and poor in monoxide, is passed over nickel as a catalytic agent, with the result that the oxide is reduced to methane, thus: $CO + 3H_2 = CH_4 + H_2O$. The result is a good illuminating gas containing about 30% methane and 62% hydrogen. The methane can easily be decomposed into carbon and hydrogen as will be seen further on.

The Griesheim Elektron Co. has perfected a method by which the CO in water gas is almost entirely replaced by hydrogen. In a special form of apparatus the gas, with the requisite amount of steam, passes at the proper temperature through wire gauze composed of catalytic metals, such as iron, nickel or platinum. The result is that CO_2 is formed in abundance, and through rapid cooling and lack of contact with the catalytic agents, there is little or no reduction to the form of the monoxide. The requisite temperature can be maintained by allowing a limited amount of oxygen to enter into the gas current—or even air if there is no objection to having nitrogen present in the residual hydrogen—after the CO_2 has been absorbed. This gives an especially economical source of hyrdogen for use in the synthesis of ammonia.

W. Naher and K. Muller claim to secure the same result by passing water gas fresh from the generator, with the requisite amount of steam, over rhodium or salladium asbestos, as contact materials, at the temp. of 800° C. The resultant CO_2 is removed by the customary absorbents, and nearly pure hydrogen remains.

Another method perfected by the Griesheim Elektron Co. is likewise yielding very good results. Water gas, hot from the generator, is passed into a heated retort and charged with quick lime in company with a current of steam. The CO reacts with the lime and steam, forming $Ca\,CO_3$ and hydrogen according to the equation $Ca\,O + CO + H_2\,O = Ca\,CO_3 + H_2$

The elimination of the monoxide is very complete. According to the size of the plant the hydrogen produced (which contains the nitrogen originally present in the water gas) costs from 8 to 10 pfennigs per cu. metre or 10 to 12 cents per pound.

Dr. F. Sauer claims to get very satisfactory results by treating water gas with an excess of super-heated steam, securing in a continuous, uninterrupted current a mixture of steam, carbon dioxide and hydrogen. The latter is easily isolated in a relatively pure condition.

An entirely different process from these has been patented by F. A. Barton. Dilute sulphuric acid is allowed to act on zinc and the zinc sulphate solution produced is filtered and mixed with a solution of sodium carbonate or bicarbonate, thus giving, as by-products, a precipitate which is separated, washed and dried, and sodium sulphate which is also recovered. The insoluble zinc precipitate is proposed as "an excellent substitute of oxide of zinc used in the paint and rubber industries." The apparatus claimed consists of a generating vessel, communicating with an acid tank by a feed pipe and a return pipe, and also with a gasometer and a mixing tank, the latter receiving the zinc sulphate solution from the generator and sodium carbonate solution from another vessel and connected in turn with a centrifugal separating and washing apparatus. The generator may be fitted with electrodes for the production of electric energy.

In most of the processes outlined the hydrogen secured is accompanied by various amounts of nitrogen which naturally do not affect its value for the synthesis of ammonia.

W. Lachmaun goes a step further. He proposes to produce the desired mixture of hydrogen and nitrogen in the proper proportions from a mixture of air and steam, 1 to 2.4. The current of such a mixture is first conducted over copper at the proper temperature, which removes the atmospheric oxygen, and then over glowing iron to remove the combined oxygen present in the steam. The resultant gas is 75% hydrogen and 25% nitrogen. A current of reducing gas is passed in the reverse direction over the oxides of iron and copper to restore them to the metallic condition. The furnace for this resembles a Hoffman brick kiln. It consists of a circle of compartments separated from each other by radiating walls. The method is ingenious, but involves no material economy of production over the separate preparation of the two gases.

Many other recent methods for the production of hydrogen need not be mentioned. They are designed more particularly to meet the demands of aeronautics, especially when a balloon gas is required at a distance from industrial centres.

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E. P. Bowman, B.A. Sc., '10, who is with the Topographical Survey Branch, Department of Interior, is now in the West in charge of D.L.S. work.

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RELATION OF THE TECHNICAL PRESS TO THE GOOD ROADS MOVEMENT*

By Hyndman Irwin, B.A.Sc.,
Managing Editor, The Canadian Engineer.

Engineering literature has as important a mission to fulfil in the field of highway work as it has in any other line of municipal or national development. It would not be difficult to substantiate a claim that it bears a much heavier responsibility here than in other phases of engineering work. For, in the road movement, as we of the present generation are obliged to regard it, we have many transitory practices to supplant, many precedents to uphold and many innovations to establish. The principles of dynamics, unchanged, of course, are served up in new and dissimilar ways, because of the variableness of traffic, climate and quality of materials. Generally speaking, each piece of work differs in several essentials from every other. The problem of making a dollar do the most work has innumerable counter-claims and conditions attached to it.

The successful engineer of today is necessarily a most diligent consumer of engineering literature. It is the most valuable instrument at his command. By it he acquires a knowledge of the experience and findings of others. To the highway engineer this knowledge is quite indispensable, particularly at this time when we are in the throes of revolutionary tendencies occasioned by the co-mingling on our thoroughfares of diversified methods of travel, heavier loads, increased speeds in every season, over arteries of commerce and pleasure fed by longer and more numerous tributaries than ever before. It is the lot of the road expert to strive constantly against the repellency of nature and the added negative influences of the transportation of man and his effects. The question of expenditure seldom allows him a conquest that is forceful and positive, but he is oblegid to be satisfied with a compromise which is temporary and in need of constant vigilance. He cannot expect his own personal judgment and experience to carry him over all the difficulties of his work. In fact, without a knowledge of the experience of others he is unable to judge from an economic standpoint the success or failure of his own. Modern highway improvement and maintenance do not entirely submit to old and well-defined principles that, once inculcated serve for all time. New methods, new machinery, new materials, up-to-date organization and management—these are vital points in the foundation upon which the good roads movement of today depends. Without a working knowledge of them the road man is not suitably equipped for his work. This knowledge, however, can be acquired in a sufficiently comprehensive degree in only one way—through the pages of the technical press.

In dealing with the relation of the technical press to the good roads movement one must include under the general title not only periodic literature, such as technical and trade journals, bulletins, proceedings of engineering and road organizations and reports of

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governmental departments, but also books, pamphlets and catalogues. They are all of value to the road expert. From catalogues, for instance, he obtains information respecting new machinery and appliances, their general construction, capacities, efficiencies and costs. This information is a very important asset as the problems of road construction, maintenance and repair, from the viewpoint of the road superintendent, are largely a matter of machinery and are rapidly providing steady employment for men who have had a training in mechanical work. Likewise the publications of producers of road materials contain information scientifically compiled and arranged in a manner that admits of ready assimilation without material effort or study. Government books of records and statistics of physical and climatic conditions, reports of official tests, etc., are of great value. In short, there are many elements of the technical press which should be included. It is the purpose here, however, to refer to the class of technical literature for which the road man is obliged to pay money; viz., books and periodicals and define their degrees of usefulness in the general establishment and upkeep of road systems.

There is something of historical interest to be said with respect to books on roads and road-making. About 4½ centuries ago a book was published in England entitled "The Duties of Constables and Surveyors of Highways." Some 25 years later another entitled "A Profitable Work Concerning the Mending of Highways" introduced the subject of road repair. These were slowly followed by others on road making. Later MacAdam, Telford and others preached new doctrines and advocated new theories. The advent of the stone crusher, the steam roller, excavating and grading machinery was followed by street cleaning apparatus and mechanical devices for surface treatment, materials for road making and paving. These innovations called for many more books and pamphlets. Then the automobile arrived with its peculiar propensities to cut holes in well established processes. It has caused deep concern in the matter of road maintenance. The resulting production of literature on the subject is fast attaining mammoth proportions.

A prominent authority on engineering literature, Mr. Harwood Frost, has stated in one of his works that he compiled a list some years ago of nearly 500 titles in the English language alone on the subject of road-making. This list covered a period of over 400 years. In the 17th century 15 books were issued, 50 in the 18th, 250 in the 19th and 150 in the first 10 years af the present century. The close of 1915 will probably see as large a number published within 5 years. The extent of road literature 20 years hence is difficult to imagine.

With the publishing houses pouring forth an avalanche of new books it is perhaps opportune to observe that there are many classes of books as well as many books on road engineering and administration. This applies, of course, to literature of all descriptions, but as at this juncture of the road movement so much dependence is to be placed on written thought, attention may well be called to its varying qualities.

Books may be based upon right or wrong theories, they may describe good or poor practice, they may be well or poorly written.

Their contents may consist of old material in new garb, or valuable and unpublished facts in unreadable form. Books may be evenly balanced, smoothly written, comprehensive treatises of principles or they may be misleading and unreliable accumulations of jumbled notions. How often we find in our libraries two books on the same subject, one a veritable interest binder and another as difficult to read as a blue book on banking statistics. Again a book may be abnormally padded with the apparent view of approaching the size of a higher priced volume, while its antithesis is found to possess in concise and logical manner, thoughts that are exceptionally clear and every thought in its proper sequence with its antecedent.

Comparatively few road men have large sums to invest on the literature pertaining to their work but when a man on the job wants information of a technical character he generally wants it badly and he is not generally so located that he can examine the reference books in the library or the samples on a publisher's shelves in order to ascertain whether or not the information he desires is contained in the books which would there be presented to him for examination. Not every man knows, moreover, just what the information which he desires to secure will entail in the matter of such examination. Book purchasing under these circumstances bears a marked resemblance to the old-time horse trade in so far as hidden qualities are concerned. The book purchaser, however, is not distrustful of the author or publisher and is more likely to infer that the book is a good one else it would not have been published. The circulars descriptive of the scope and qualities of the published work should naturally be expected to bring out the good points which it may possess, but other features, perhaps undesirable, may be quite overlooked. It is to be remembered that among the very reputable publishers of engineering works even the best are not immune from misjudging a manuscript which may, when published, prove to fall very short of expectations, and to be unauthentic on some of its important statements.

Evidently the selection of sources of technical information is an important one to the road expert. Briefly the reviews of newly published books, to be found in the recognized technical journals have gradually become, through a process of evolution, beginning with a general rehash of the author's preface, an unprejudiced and straight-forward summary of the scope and fundamental features which a book may possess. Such reviews can be depended upon. Journals that devote space to them are cultivating the practice of careful criticism. The result is noticed in the discrimination on the part of the publisher in the matter of sending books to these journals for review. The publisher who desires to increase the sale of an unlikely book would rather have it left unreviewed than severely criticized; hence, the reader may safely increase his dependence upon the books which are reviewed in such journals provided the review discloses an indication of the sort of information he is after.

The value of keeping up-to-date in technical reading cannot readily be overestimated. This is so widely recognized that little reference need be made to it here. There are books on roadwork

that are out of date in many of their statements before they have been in print for five years, or even less. The growth of road literature as a result of new types and new methods is a fair example of the varying tendencies of general practice. In order to keep pace, therefore, with the new developments in the field of road building it is necessary to be in touch with the best technical literature of the day on the subject.

Reverting to technical periodicals on roads a century ago they were practically non-existent. Since then the inception of numerous local and national organizations, with their proceedings devoted to paper and discussions presented in their meetings, and the birth of scores or more of technical journals, also of thousands of trade publications issued by manufacturers, have more or less adequately responded to the need for the broadcasting of information. When we consider what is being accomplished in America in this respect, and add to this the production of similar literature in the civilized countries of the old world, the bulk of printed material on roads assumes gigantic proportions.

Evidently there is the necessity for careful selection on the part of those having to do with this movement and its literature. No man can read by any means all of the information which is presented. Yet the old saying that "experience is the best teacher" was never truer in any line of industry, it being universally accepted, of course, that no man can ever expect to achieve success if he depends solely on his own experience for enlightenment. It is upon the experiences of others, as already stated, that he very largely depends, and in the record of such experiences lies the reason for the existence of the technical press. The technical journal benefits its readers by conveying to them first-hand the sort of information that is not yet to be found in the pages of treatises on the subject. It outlines methods of doing work that are newer and better than others. It describes the maiden efforts of machinery, tools, and processes recently devised. It thoroughly investigates the achievements of progress and endeavors to present them in the most acceptable way for the general good of mankind. It is, therefore, an indomitable factor in the equipment of the man associated with the good roads movement.

The problem of culling from the growing mass of road literature that which he needs most is an important one for the road engineer. To illustrate its extent we may refer to the recently issued Good Roads Year Book for 1914 of the American Highways Association. It is found to contain a section devoted entirely to a summary of articles published in 1913 in the various journals devoted to the movement. It lists over 650 articles published in that year alone, besides innumerable bulletins, circulars, pamphlets and documents. It also contains a list of texts including over 400 books. Evidently there is plenty of material with which a man may equip himself, but a wise selection is a difficult matter.

Of course, the road man is not alone on the problem. The publishers of this information are fully aware of it, recognize its importance, and are endeavoring to present the desired information in such a way that he can readily make practical use of it. The rest

devolves upon himself, and in this age of specialization the problem is not without serious difficulties. The road man is unwise if he limits the scope of his reading to that which satisfies his immediate needs and them alone. Those who achieve the fullest measure of success in any walk of life are those who have worked, read and thought more than was absolutely necessary for the carrying out of whatever work was in hand. It is this superfluous labor and desire for supplementary knowledge that equips one for the things in life that count, by storing the additional knowledge as a sort of emergency reserve. This is readily illustrated in the field of road work. A man interested therein is also interested in methods of surveying, drainage, construction of dams and bridges, mechanical operation of machinery, transportation of materials, use of cement and concrete, geology of rocks and clays, and the road laws of the country. Manifestly there is no defining line between his work and that of men in numerous other phases of development. Therefore, if a road engineer is judicious and discreet he will read that literature which pertains to his own special work—and much more.

Finally, there is the important question of the preservation and filling of technical literature. This applies chiefly to periodicals. Once in a while the road man may be unable to peruse his journals as he would like owing to press of duties. He may glance over an article that promises to be of value to him but is obliged to lay it aside for further consideration, and it may be misplaced or forgotten. The obvious solution lies in the method adopted by almost every up-to-date engineer in other lines of work—that of carefully examining the journal when it is received, and having all articles that have a bearing upon his work listed in a card index system. In a few years every phase of work with which he has to do will be well represented. If he has been wise he will have had his periodicals bound. He is then equipped with a library of information that is of the greatest value to him. He may, for instance, meet a problem which requires additional knowledge of sub-drainage. His card index immediately brings before him a summary of all the information on the subject that has been published by his journals since he began the system, and reference to the articles indicated places him in possession of the required data. They are not the opinions of one man, but of many. Moreover, they are not from an early edition of a volume that has since been succeeded by others which may not be in his possession. He has all the information of intervening years before him. He is not necessarily a voluminous and costly library, but one that is ready to serve him well in more ways than one. Besides acquainting him, on the publication of each issue, of the new methods and new machinery just sprung into use, and of road activities in other countries and in other sections of his own, his periodicals, if used in a scientific manner, soon create a reference library for him of excellent quality that can be added to at small cost as years go on, the whole system thereby becoming more valuable.

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EDITORIAL

ALUMNI DIRECTORY

We wish to express the indebtedness which we feel toward a number of our graduates who have forwarded information to us concerning themselves and other graduates. It is a difficult task to "round up" the information for the Alumni Directory, and we would appreciate very much if our readers would lighten our labors, by sending us any information which they can, that would make the Directory more complete and more reliable. We would direct your attention in particular to those whose addresses we have not on fyle, or concerning whose professional work we have no record. If you change your own address or occu-

pation we would like you to write to us and draw our attention to the fact. A change of address on a letterhead might easily be overlooked unless our attention is directed to it, for otherwise it would be necessary to compare each piece of correspondence with our records to find out whether the address had been changed or not.

PROFESSOR C. H. C. WRIGHT MEETS "SCHOOL" MEN IN THE WEST

Professor Wright has just returned from a month's visit throughout Western Canada, and brings back glowing reports of what our graduates are doing in that part of the Canada Dominion. The "School" has undoubtedly placed her imprint on the West and it is after a few weeks' immediate contact with the activities of the Western provinces that one begins to fully realize the magnitude of the part which Dean Galbraith and the "School" are playing in developing that newer part of Canada. Throughout his entire journeying Professor Wright was in the company of "School" men practically all the time. A Toike-oike atmosphere seemed to surround him everywhere he went, and the enthusiastic loyalty, characteristic of "School" men, seemed to have been given increased impetus by the energetic influences of Western activities.

On the evening of Monday, June 1st, the graduates in Edmonton tendered a luncheon to Professor Wright at which Mr. J. Chalmers, '94, acted as chairman and toastmaster. The others present were: A. T. Fraser, '94, G. H. Richardson, '88, R. H. Knight, '02, A. J. Latornell, '03, H. H. Depew, '04, E. M. M. Hill, '04, Kells Hall, '07, D. D. MacLeod, '10, V. A. Newhall, '10, G. G. Macdonald, '15, C. I. Grierson, '14, L. P. Yorke, '11, R. M. Christie, '14, H. Goodridge, '10, R. H. Douglas, '09, A. W. Pae, '09, C. C. Sutherland, '09, W. W. Gray, '04, B. F. Mitchell, '06, J. H. Smith, '03, H. L. Seymour, '03, A. J. Huff, '11, and A. J. Sill.

The graduates in Edmonton decided at the luncheon, that they would organize a branch of the Alumni Association in the near future, and no doubt have acted upon their decision before this has gone to press.

The Winnipeg graduates, who quite recently organized a branch of the Alumni Association, tendered a luncheon to Professor Wright at the St. Charles Hotel on June 16th. In spite of the fact that everything was arranged with only a day's notice after Professor Wright's arrival in the city, a large number were present, although some were unable to attend owing either to absence from the city or insufficient time to receive notification. Those who were present were: Wm. Fingland '93 (chairman), L. T. Burwash, '96, Donald A. Ross, '98, W. P. Brereton, '01, R. A. Sara, '09, J. B. Ferguson, '09, F. F. Phillips, '09, A. W. Lamont, '09, O. E. Harman, '95, H. Helliwell, '94, R. A. Paul, '11, R. D. Torrance, '11, J. Young, '07, L. R. Brereton, '13, J. L. Whiteside, '10, H. P. Frid, '11, N. C. Sherman, '10, E. H. Niekel, '11, H. E. Brandon, '06, J. B. Minns, '07, W. C. Foulds, '10, G. A. Warrington, '10, M. V. Sauer, '01, J. F. S. Madden, '02, W. G. Chase, '01, F. H. Alexander, '97, and A. A. McQueen, '11.

A DRAFTSMAN'S DETAILS

By A. T. N.

Oh what a life
The draftsman leads,
In this old world today;
He draws his plans,
He draws his breath,
He draws also his pay.
His weary hours
Are long-drawn out,
While waiting for a "raise";
His wrinkled brow
Is drawn down more,
No increase meets his gaze.
He fills his pen,
Then draws a line,
And mutters "Things ain't square,
I think I'll chuck
This bloomin' job
For one with more fresh air,
I glue my nose
Down to my board
The bloomin' live-long day;
The bloomin' boss
Is standing near,
To see I earn my pay!
The boss, he thinks
I ought to know
All things from A to Z,
And still be glad
To work for him
At what he now pays me.
This drafting life
Is 'on the Fritz,'
It surely makes me 'sore!!'"
He "beats it" home
But in the morn'
He comes right back for more.

—Engineering News.

LEAVER—PALMER

Mr. Chas. B. Leaver, B.A.Sc., '10, was united in marriage to Miss Olive Vera Palmer, on Wednesday, June 10th at the home of the bride's parents, Mr. and Mrs. Wilberton C. Palmer, Woodrowe Beach, Sarnia, Ontario. Applied Science extends congratulations.

A correspondent sends us the following "pome," by J. B. Randall in the Malheur Mining News:

MINING EXPERTS

Come, listen, fellow miners, and a tale I will relate
'Bout the facts concerning mining, right here within this state;
This country's overburdened with so called mining men
Who will bond a mine, black-eye the camp; then leave the state again.

They put on their yellow leggins, and with little pick in hand,
Look wise and air their knowledge and ignore a common man;
They talk about geology, or some rock which ends with —ite.
Then build a good-sized stamp mill—not a pound of ore in sight.

Here's a case in plain philosophy—come, listen, if you will—
If you educate a burro, you will have a burro still,
And your college-bred expert is just as competent
As this animal I've mentioned for a superintendent.

See the stamp mills lying idle, about a score or more;
First-class mine equipment, with not a pound of ore!
Why? Because they "learned" their "mining" (not underground, I say),
But in some eastern college—that's why our mines don't pay.

A word to you investors who are seeking mining claims:
When you send out your agent, send out a man with aims,
Commission a real miner to investigate the mine,
Not a man who's never seen one—it isn't in his line.

For there's failure after failure, recorded every year.
And pocketbooks depleted by sending "experts" here;
Yet we have dividend-payers, soon they'll begin to loom;
Mark you well! the town of Malheur will once more commence to boom.

A. J. McLaren, B.A.Sc., '11, is with the Westinghouse Church Kerr Co., engineers and contractors, on their work of alterations and additions to the C. P. Ry. terminals at Winnipeg.

G. L. Wallace, B.A.Sc., '11, and J. H. Hawes, B.A.Sc., '14, have recently been appointed to the staff of the Topographical Surveys Branch, Dept. of Interior, Ottawa.

W. C. Cale, B.A. Sc., '10, formerly with the Stone & Webster Engineering Corporation, Keokuk, Ia., is now with the Mississippi River Power Co. of that place.

E. A. Twidale, B.A. Sc., '14, is with the National Electrolytic Co., Niagara Falls, N.Y.

WHAT OUR GRADUATES ARE DOING

S. Kidd, '16, is in the chief architect's office, Department of Public Works, Ottawa, Can.

C. T. Hamilton, B.A. Sc., '07, is a member of the firm, Broadfoot, Johnston & Hamilton, (W. J. Johnston, '09, and F. C. Broadfoot, '06), engineers, contractors and land surveyors, 73 Exchange Bldg., Vancouver, B.C. The information in the directory last month was incorrect.

D. H. Campbell, B.A., Sc., '14, is with the Topographical Surveys Branch, Department of Interior, Ottawa, Can.

F. C. White, B.A., Sc., '09, who is with the Canadian Bridge Co. of Walkerville, is at present at Prince George, B.C., where the company is erecting a bridge across the Fraser River for the Grand Trunk Pacific Railway. The bridge includes a 100 foot lift span to be electrically operated. The whole development of the electrical features is under Mr. White's supervision.

J. A. Walker, B.A. Sc., '08, is in charge of the British Columbia Government's survey work in the valley of the South Fork of the Fraser River, along the main line of the Grand Trunk Pacific Railway.

L. W. Rothery, B.A. Sc., '11, has severed his connections with the Allis-Chalmers Mfg. Co., and is now with the Westinghouse Machine Co., at Turtle Creek, Pa.

W. J. T. Wright, B.A. Sc., '11, and J. T. Howard, B.A. Sc., '13, are in partnership in architectural engineering. Their offices are at 121 Simcoe St., Toronto.

A. B. Garrow, B.A. Sc., '07, formerly assistant engineer, main drainage department, City Hall, Toronto, is now with the Toronto Harbor Commission, designing the new sewer outlets along the waterfront.

W. A. Richardson, B.A. Sc., '11, is with the Bates & Roger Construction Co. of Chicago and Spokane, U.S.A. He is at present engineer for that company on the erection of a half-mile bridge across the Fraser River, at Fort George, B.C.

J. M. Duncan, B.A., Sc., '10, is with the Wallsend Slipway & Engineering Co. at Newcastle-on-Tyne, England.

W. G. Ure, B.A. Sc., '13, has recently been appointed assistant to the city engineer at Stratford, Ont.

E. T. Austin, B.A., Sc., '09, has been appointed smelter superintendent of the Mond Nickel Co.'s smelter at Coniston, Ont.

E. R. Frost, B.A. Sc., '09, is night mechanical engineer for the Foundation Co. on the C.P.R. elevator at North Transcona, Man. Mr. A. W. Chestnut is assistant field engineer on the same work.

F. F. Phillips, '08, is chief draughtsman for the C.P.R. lands department at Winnipeg.

DIRECTORY OF THE ALUMNI

Hyland, H. M., '07, is a member of the Hyland Construction Co., railroad contractors, Toronto.

Hyman, E. W., '07, lives in London, Ont., where he is assistant superintendent of the London Electric Co.

I

Iler, S. B., '08, is assistant engineer with the Brantford Hydro-Electric System, Brantford, Ont.

Ingles, C. J., '04. We have not his present address.

Innes, W. L., '90, is general manager of the Dominion Canners Limited plants at Simcoe, Ont.

Ireland, L. G., '07, is manager of the Brantford Hydro-Electric system, Brantford, Ont.

Ireson, E. T., '13.

Irvine, J., '89, deceased.

Irwin, H., '09, is managing editor of *The Canadian Engineer*, Toronto.

Irwin, W. J., '10, is with the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

Isbister, J., '09, is electrical superintendent for the Mond Nickel Company at Coniston, Ont.

J

Jackes, F. P., '09, is commercial engineer for the Bell Telephone Co., Toronto.

Jackson, J. G., '03, was at Kingston, Ont., when last heard from.

Jackson, F. C., '01, is a member of the firm of Jackson & Connelly, railway contractors, La Tuque, P.Q.

Jackson, W., '07, is with the Ontario Power Co., Niagara Falls, Ont., as field engineer on construction.

Jackson, C. B., '07, is in Kenilworth, Ill., in the estimating department, C. Everett Clark Co., Limited.

Jackson, J. E., '09. His home is at Oxford Centre, Ont.

James, O. S., '91, has a practice as assayer and chemical analyst, in Toronto.

James, D. D., '89, resides in this city. He is senior member of James & James, Ontario land surveyors.

James, E. A., '04, is chief engineer, York County Highway Commission, and member of the firm of James, Loudon & Hertzberg, Toronto.

James, E. W., '09, resides in Winnipeg, Man., where he is engaged in the Public Works Department.

James, F. L., '10, whose home is in Tillsonburg, Ont., has no business address with this office.

Jarvis, R. H., '11. We have not his present address.

Jepson, W. C., '06, is assistant engineer, Welland Canal office, Niagara Falls, Ont.

Jeffrey, D., '82, has had no record of address with us for a number of years.

Jermyn, P. V., '04, is engineer for the Reg. N. Boxer Wall Paper Co., Limited, of New Toronto, Ont.

Job, H. E., '94, is manager of the Toronto and Hamilton Electric Co., Hamilton.

Johnson, C. C., '09, is with Chipman & Power, engineers, Toronto. He is at present at Wallaceburg, Ont.

Johnson, G., '96, has a practice as mining engineer at Castleford, Ont.

Johnston, D. M., '02, resides in Toronto. He is with the Hydro-Electric Power Commission as construction engineer and inspector.

Johnston, H., '03, is city engineer of Berlin, Ont.

Johnston, H. C., '10, is looking after the Toronto interests of Anglin's Limited, building contractors, Montreal.

Johnston, A. C., '94, is vice-president and chief engineer of the J. M. Dodge Co., Philadelphia.

Johnston, S. M., '94, is engaged in land surveying in British Columbia.

Johnston, H. A., '00, has Stettler, Alberta, for his present address. We do not know the nature of the work in which he is engaged.

Johnston, J. C., '00, has no address whatever with us at present.

Johnston, J. A., '00, resides at Ignace, Ont., where he is engaged in general contracting.

Johnston, C. K., '03, has a business as general merchant at Pefferlaw, Ont.

Johnston, R. H., '10, is engaged in survey work in Toronto.

Johnston, W. J., '09, is a member of the firm of McKenzie, Broadfoot & Johnston, engineers and contractors, Vancouver, B.C.

Johnston, C., '06, is district engineer for the Canadian Northern Railway at Hamer, Ont.

Johnston, C. E., '09. Deceased, Dec. 31st, 1913.

Johnston, J. T., '08, is hydraulic engineer in the Water Power Branch, Department of Interior, Ottawa.

Jones, J. E., '94, is with the streets commissioner, City Hall, Toronto.

Jones, L. E., '11, is a member of the firm Jones & Cornell, engineers and contractors, New Westminster, B.C.

Jones, G. S., '05, has for his home address Smiths Falls, Ont. He has no business address with us.

Jones, G. R., '06, is engaged in missionary work in China.

Jones, T., '06, is general manager of the Canadian Brake Shoe Company, Montreal.

Junkin, R. L., '13, is with the Federal Improvement Commission of Ottawa and Hull.

Jupp, A. E., '06, is assistant engineer with Routley & Summers, in their Toronto office.

K

Kay, E. W., '07, is assistant manager of the Reinforced Brickwork Co., Limited, with head office at Winnipeg.

Keefe, W. S. H., '04, is manager of the Light, Heat & Power Co., Fort Covington, N.Y.

Keele, J., '93, is engineer for the geological surveys branch, Department of the Interior, Ottawa.

Keffer, A. H. E., '09, is resident engineer, T. & N. O. Railway, near North Bay, Ont.

Keith, J. C., '10, is engaged in contracting and surveying, Calgary and Moose Jaw.

Keith, D. F., '07, is a member of Keith's Limited, mechanical and electrical contractors, Campbell Ave., Toronto.

Keith, H. P., '07, is a member of the city commissioner's staff, Moose Jaw.

Kelly, E. A., '11, is resident engineer at Winnipeg for the Canadian Pacific Railway.

Kemp, J. B. O., '09, is structural steel draughtsman for the Toronto Structural Steel Co., Toronto, Ont.

Kennedy, J. H., '82, is assistant chief engineer of construction for the Vancouver, Victoria & Eastern Railway & Navigation Co. at Vancouver, B.C.

Kennedy, H. G., '08, is at Cobalt, Ont., as engineer for the Cobalt Lake Mines.

Kennedy, M. D., '09, is manager of the Beaconsfield Consolidated at Elk Lake, Ont.

Keppy, J. D., '06, has an office at 50 Pearl St., Toronto, where he has a practice as mechanical engineer.

Kerr, A. E., '13. We understand he is with the Canadian Westinghouse Company, Hamilton.

Key, W. R., '09, is assistant engineer for the Turnbull Elevator Co., Toronto, Ont.

Kettle, T. H., '09, is assistant sales manager, Milwaukee Light & Power Co., Milwaukee, Wis.

Keys, W. R., '08, is at North Bay, Ont., as resident engineer for the T. & N. O. Railway.

King, C. F., '97, is Toronto representative of the *Financial Times*, Montreal.

King, J. T., '10, is demonstrator in the Department of Mining, Faculty of Applied Science, University of Toronto.

Kinghorn, A. A., '07, is president and general manager of the Asphaltic Concrete Co., 24 King St. E., Toronto.

Kingstone, G. A., '10, is Toronto representative for Jones & Glassco, Montreal.

Kirkland, W. C., '84, is principal assistant engineer, drainage, sewage and water board, of New Orleans, La.

Kirkwood, M., '11, is with the American Telephone & Telegraph Co., New York city, in the engineering department.

Kirwan, G. L., '10, is in the topographical surveys branch, Department of the Interior, Ottawa.

Kirwan, P. T., '10, is at Ottawa, Ont. His address is Westminster Apts., Ottawa.

Klingner, L. W., '07, is with the Dominion Construction Co. Limited, of Toronto, at their office in Belleville, Ont.

Klotz., H. N., '09, is chemist for the Gutta Percha Rubber Co., Toronto.

Knight, R. H., '02, is a member of the firm of Driscoll & Knight, engineers and surveyors, at Edmonton, Alta.

Knight, S., '10, is in the employ of Driscoll & Knight, Edmonton, Alta.

Kormann, J. S., '98, is general manager of Kormann Brewing Co., Limited, Toronto.

Kribs, G., '05, is with the Hydro Electric Power Commission, Toronto.

L

Laidlaw, J. T., '93, has a practice as consulting minnig engineer at Cranbrook , B.C.

Laidlaw, R. A., '01, is engineer and

sales agent for the Trussed Concrete Steel Co., Houston, Texas.

Laing, W. F., '96, (deceased).

Laing, A. T., '92, is secretary of the Faculty of Applied Science and Engineering, University of Toronto, and lecturer in Highway Engineering.

Laing, J. S., '13, is assistant to the town engineer at Galt, Ont.

Laing, P. A., '05, is divisional engineer for the Transcontinental Ry. at Cochrane. Address is Div. 3-4, c. T. C. Ry., Cochrane, Ont.

Laird, R., '86, is a member of the firm of Laird & Routley, engineers and surveyors, Haileybury, Ont.

Lamb, F. C., '07, is with Phillips, Stewart & Lee, engineers, at Saskatoon, Sask.

Lamb, G. J., '09. The only address we have on fyle is Walkerton, Ont.

Lamont, A. W., '09, is assistant engineer with the Canadian Westinghouse Co., 158 Portage Ave., Winnipeg, Can.

Lane, A., '91, (deceased).

Lang, A. G., '03, is underground superintendent for the Toronto Hydro-Electric system, Toronto, Ont.

Lang, J. L., '06, is a member of the firm of Lang & Keys, engineers and surveyors, Sault Ste. Marie, Ont.

Langley, C. E., '92, is a member of the firm of Langley & Howland, architects, Continental Life Building, Toronto, Ont.

Langmuir, C. B., '09, is manager of the electrical department for the Factory Products, Limited, Toronto, Ont.

Langmuir, F. L., '02, is chemist for the M. Langmuir Manufacturing Co., Toronto, Ont.

Lanning, J., '11, is with Routley & Summers, engineers and surveyors, Haileybury, Ont.

Larkworthy, W. J., '04, deceased.

Laschinger, E. J., '92, is mechanical engineer with H. Eckstein & Co., Johannesburg, Transvaal, S.A.

Lash, F. L., '93, is manager of the Electrical Supply Co., Board of Trade Building, Bandoeng, Java.

Lash, N. M., '94, is assistant electrical engineer with the Bell Telephone Co., Montreal, P.Q.

Latham, R., '99, is chief engineer, T. H. & B. Railway. His address is 146 Aberdeen Ave., Hamilton.

Latornell, A. J., '03, is city engineer for Edmonton, Alta.

Latornell, A., '05, is assistant engineer in the sewer department, City Hall, Toronto.

Lavrock, J. E., '98, was draftsman for Herman & Burwell, engineers, Vancouver, B.C., when last heard from.

Lawler, E. R., '10, is engaged as inspector with the Toronto Hydro Electric system, Toronto, Ont.

Lawless, N., '11. We do not know his address.

Lawson, W. L., '92, is manager of the Great Western Sugar Co., Sterling, Col.

Lawrie, R. R., '96, deceased.

Leadman, H. L., '11, is with the department of naval service, Hydrographic Survey, Ottawa, Ont.

Leaver, C. B., '10, has Sarnia as his address with us.

Lee, W. A., '92, deceased.

Lee, R. G., '10, is assistant sales manager with the Toronto Hydro Electric system.

Leighton, J. W., '05, is president of the Leighton-Jackes Mfg. Co., Toronto, Ont.

Leitch, J. N., '10, deceased.

Lennox, A. E., '09, is publicity engineer for the National Electric Lamp Association, Cleveland, Ohio.

LePan, A. D., '07, is assistant superintendent of Buildings and Grounds, University of Toronto.

Leslie, A., '13, is with the Bell Telephone Co., Toronto, Ont.

Leslie, J. N. M., '08, is with the Canadian Westinghouse Co., Toronto, as sales engineer.

Lethbridge, W. R., '11, is at Cumberland, B.C. We do not know the nature of his employment.

Lewis, F. C., '08. His address is 637 Somerset Block, Winnnpeg, Man. We do not know the nature of his work.

Leibermann, M., '11. His address is care of H. A. Friedmann, barrister' solicitor, etc., Rudyk Bldg., Edmonton, Alta.

Lillie, G. L., '11, is with the Toronto Hydro Electric System in the distribution department, Toronto.

Lindsay, J. H., '07, is district surveyor and engineer, Prince Albert Public Works District, Prince Albert, Sask.

Linton, A. P., '06, is with the Board of Highway Commissioners, Regina, Sask.

Livingston, H. D., '13, is a member of Angus & Angus, architects, engineers and surveyors, North Bay and Sudbury, Ont.

Lloyd, N. C. A., '09. We do not know his address.

Long, A. L., '11, is chemist for Park, Blackwell & Co., Toronto, Ont.

Longstaff, J. C., '10. We do not know where he is employed.

Lott, A. E., '87, has a practice as consulting railway engineer, 441 Bradbury Building, Los Angeles, Cal.

Loucks, R. W. E., '09, is a member of the firm of Brown & Loucks, engineers and contractors, Saskatoon, Sask.

Loudon, T. R., '05, is lecturer in metallurgy, University of Toronto. He is also a member of the firm of James Loudon & Hertzberg, engineers, Toronto.

Lowrie, A. W. P., '11. We do not know his address.

Ludgate, B. A., '85, is assistant engineer for the P. & L. E. Railway, Pittsburg, Pa.

Lumbers, W. C., '01, is assistant engineer with Frank Barber, Toronto.

Lynar, H. R., '08, is employed on the Welland Ship Canal at St. Catharines, Ont.

Lytle, L. B., '13, has Tralee, Ont., as his permanent address.

Mac

Macallum, A. F., '93, is city engineer at Hamilton, Ont.

MacAndrews, W. M., '11, was with the Allis-Chalmers-Bullock Co., Dominion Trust Building, Vancouver, B.C., as assistant sales manager when last heard from.

Macauley, R. V., '11, is commercial engineer, Montreal Division, Bell Telephone Co. of Canada. His address is Central Y.M.C.A., Montreal, Que.

MacCarthy, T. V., '13, is assistant engineer on pitometer surveys, waterworks department, City Hall, Toronto.

MacColl, E. B., '11, is assistant engineer, Hydrographic Survey, Department of Naval Service. Address mail to Hydrographic Survey, Ottawa.

MacBain, J. T., '11, 124 Fourth St., Niagara Falls, N.Y.

MacBeth, C., '96, deceased.

MacBeth, R. E. A., '11, is with the Roadways Department, City Hall, Toronto.

MacDonald, A. D., '10, is assistant superintendent, Penn-Canadian Mines, Cobalt, Ont.

MacDonald, J. B., '10, is district manager for the Canadian Inspection & Testing Laboratories at Winnipeg.

MacDonald, J. A., '10, is employed in surveying in the West.

MacDonald, G. A., '10, is at Fernie, B.C., where he is engaged in Dominion and Provincial Land Surveying.

MacDonald, F. M., '11, is a contractor with the Randolph MacDonald Co. Limited, Toronto. His address is 3 Rusholme Rd., Toronto.

MacDougall, A. C., '01, was assistant superintendent of the Aluminum Co. of America, Massena, N.Y., when last heard from.

MacFarlane, E. D., '09. We do not know his address.

MacGregor, A. E., '10, is with Chipman & Power at the city engineer's office, London, Ont.

MacKay, A. G., '07. We do not know his address.

MacKay, J. T., '02, is an undergraduate in the faculty of medicine at the University of Toronto.

MacKay, E. G., '10, is a member of the firm, MacKay, MacKay & Webster, civil engineers and surveyors, 607 Bank of Hamilton Bldg., Hamilton, Ont.

MacKenzie, H. R., '13, is inspecting engineer, Board of Highway Commissioners, Regina, Sask.

MacKenzie, H. A., '13, has Hyde Park, Ont., as his home address.

Mackenzie, K. A., '06, is a member of the firm of K. A. Mackenzie & Co., Ft. George, B.C.

MacKenzie, W. S., '11, is with the Canadian Linderman Co., Limited, Woodstock, Ont.

MacKinnon, J. G., '09, is resident engineer for the C. N. Railway at Albreda Summit, Rocky Mountains. His P. O. address is Henningville, B.C., via Edmonton, Alta.

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MacLaurin, J. G., '11, is in the water power department of the Algoma Steel Corporation, Sault Ste. Marie, Ont.

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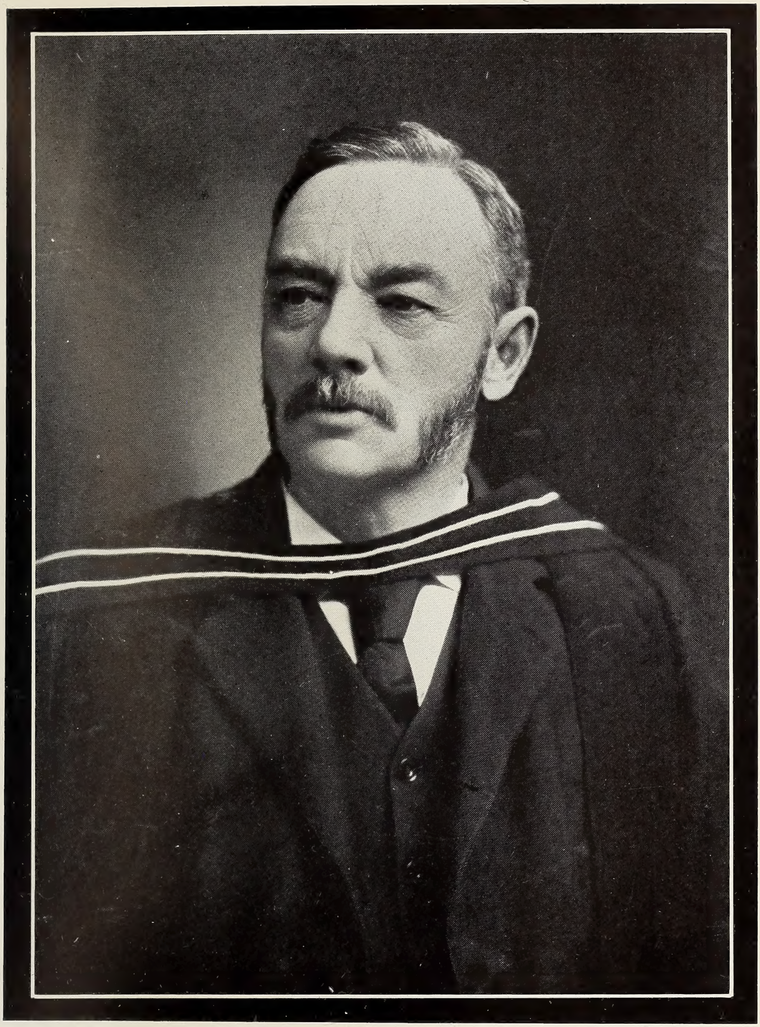

J. Galbraith

Born Sept. 5th, 1846
Died July 22nd, 1914